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To study the effect of sulphur levels and biofertilizer on solubility of rock phosphate

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Abstract
The available and total P content increased in all the treatments with microbial incubation and elemental sulphur application. It can therefore be concluded that the release of phosphorus from rock phosphate can successfully be done by application elemental sulphur @ 60 kg ha-1 along with incubation of PSB and EM solution. The available and total phosphorus content of soil was increased with increase in the incubation period stage up to 90 days.
The alkaline phosphatase activity was highest at the 30 day incubation stage. The phosphatase activity was decreased slightly at the 60 days stage and was observed to be lowest at the 90 days incubation stage. The higher phosphatase activity at 30 day and 60 day stage indicated higher microbial population at the initial stages of incubation of the microbial treatments.

Keywords: rock phosphate, sulphur and biofertilizer

Introduction
Soybean [*Glycine max.* (L.) Merrill] is one of the most versatile crop, yielding oil and protein across a wide range of the environmental conditions. Soybean belongs to the leguminaceae family. Originated from South East Asia. It is the cheapest and main source of dietary protein of majority vegetarian Indians.
Rock phosphate is one of the basic raw material required for manufacture of phosphatic fertilizers, like single superphosphate, diammonium phosphate and nitro-phosphate etc. Rapidly increasing prices of soluble phosphatic fertilizer have raised interest in cheaper alternatives. Under such circumstances new methodologies for the utilization of indigenous low grade rock phosphate by converting it into a potential source of P for direct soil application must be explored. The use of slow release phosphatic fertilizer, a cheap source of P to plants can be exploited by amending them properly. The dissolution of rock phosphate can be increased by amending them with elemental sulphur. Rock phosphate when added along with elemental sulphur undergoes a series of reactions to finally form monocalcium phosphate. The elemental sulphur undergoes oxidation. The SO4 ions combine with the hydrogen ions on dissociation of water molecules to form sulphuric acid. The sulphuric acid so formed reacts with the rock phosphate to form monocalcium phosphate, which is an available form of phosphorus. Therefore, direct soil application of indigenous rock phosphate along with P solubilizing culture, EM solution and elemental sulphur can solubilize the insoluble rock phosphate in available form. This will save valuable foreign currency on import of phosphatic fertilizers.

Materials and Methods
The present investigation was carried out with soil incubation and a pot culture experiment to study the phosphorus availability from rock phosphate as influenced by elemental sulphur and biofertilizers.

Soil
The soil selected for present study was of Inceptisol order. The soil at 0-15 cm depth was collected from the Post Graduate Research Farm, dried in diffused sunlight and was pounded and sieved. Three kilogram soil was filled in plastic bowls for the incubation study. The soil moisture was maintained at field capacity during incubation period. The another five kilogram soil from the same locations was filled in earthen pots for the pot culture experiment on

Table 1: Properties of soil used for the experiment

Property	Value
pH (1 : 2.5)	8.2
EC (dSm-1)	0.37
Organic Carbon (%)	0.69
CaCO3 (%)	6.25
Available N (kg ha-1)	150.5
Available P (kg ha-1)	15.23
Available K (kg ha-1)	519.68
Soil Sulphur (mg kg-1)	9.047
Total P (mg kg-1)	330.62
AB-DTPA micro-nutrients (□g g-1)	Fe - 4.40, Mn - 4.90, Zn - 0.78, Cu - 0.64
Microbial count (x 105 cfu g-1 soil)	Bacteria - 15.30, Fungi - 7.84

2. Rock Phosphate

The fine powder of rock phosphate was analyzed for P fractions (total, citrate soluble and water soluble P2O5) and CaCO3 equivalent by using standard methods of analysis given in Table 2.

Table 2: Characterization of rock phosphate

S. No.	Parameter of Rock Phosphate	P2O5 (%)
1	Total P2O5	19.17
2	Citrate soluble P2O5	1.4
3	Water soluble P2O5	-

3. Microbial culture for incubation study

1. Phosphorus solubilizing bacteria – 10 kg PSB/ha through soil
2. EM culture (Effective micro-organism culture) 25 lit drenching/ha through soil at 0,15,30 days
3. EM culture contains Lactic acid bacteria: *Lactobacillus casei*
   Photosynthetic Bacteria: *Rhodopseudomonas palustris*
   Yeast: *Saccharomyces cerevisiae*

4. Microbial culture for Pot culture experiment

1. Rate of PSB : 250 g/10 kg seed
2. Rate of EM culture : 25 lit/ha through drenching in soil at 0, 15, 30 days

Elemental sulphur three levels

S0 – 0 kg ha-1 sulphur
S1 – 30 kg ha-1 sulphur
S2 – 60 kg ha-1 sulphur

Incubation study

The incubation study was conducted under ambient climatic conditions in the green house of the Department of Soil Science and Agricultural Chemistry. Plastic bowls of 5 kg capacity were procured and filled with 3 kg, 2 mm sieved soil in twenty eight pots of two replications. The soil in bowls was wetted with water up to field capacity and the moisture was maintained at field capacity. Then rock phosphate was added as per treatment. The soils were mixed thoroughly with rock phosphate, sulphur and bio fertilizer as per treatment. The plastic bowls were kept for incubation for 30 days. The same set of experiment was incubated for 60 and 90 days in two replications each. The soil samples from each treatment were analyzed after 30, 60 and 90 days of incubation for alkaline phosphatase enzyme activity, available P and total P content.

Statistical analysis of the data obtained from incubation study and the pot culture experiment were done by using completely randomized design analysis for CRD as suggested by Panse and Sukhatme (1978) [7].

Results and Discussion

Available phosphorus

The data presented in Table 3 revealed that the highest available phosphorus content was recorded in the treatment T2 (general recommended dose) which was significantly superior over rest of the treatment except the treatment T14 rock phosphate + sulphur @ 60 kg ha-1 + PSB + EM solution. The results of incubation study at 90 days as incubation revealed that there was a slight decrease in available phosphorus in all the treatments as compared to the available phosphorus at 30 and 60 days of incubation.

It was observed that the available phosphorus content in the soil at all the incubation period in the general recommended treatment (T2) was the highest (P was supplied through single superphosphate). The available phosphorus content was observed to increase in the treatments of rock phosphate along with PSB and EM solution and elemental sulphur. The available P content was observed to be the highest in treatment T14 (RP + 60 kg ha-1 S + PSB + EM solution) at all the incubation period, which may be attributed to the increased dissolution of rock phosphate due to elemental sulphur and biofertilizers. Roy *et al.* (1999) [9] observed that the application of phosphor bacteria along with Mussorie rock phosphate significantly increased the available P in the soil over control treatment. Ashby *et al.* (1966) [3] also observed that coating of rock phosphate granules with elemental sulphur increased P recovery significantly. Ali (1991) [1] observed a synergistic interaction between P and S for soybean in the 80 kg P2O5 ha-1 dose.

Total phosphorus

The data presented in Table 3 revealed that, highest total phosphorus content was recorded in the treatment T2 (general recommended dose) at 30 days of incubation and the results of incubation study at 60 and 90 days showed that, highest total phosphorus content in soil was recorded in the treatment T14 (rock phosphate + sulphur @ 60 kg ha-1 + PSB + EM solution) and was significantly superior over all the treatments. However, gradual decrease in total phosphorus was observed at 90 days of incubation, in all the treatments over 60 days of incubation. This showed that sulphur and P solubilizers playsan important role in increasing the total phosphorus content in soil.

Alkaline phosphatase activity

The alkaline phosphatase activity (mg P-nitrophenol mL hr-1) was the highest in the T14 treatment i.e. Rock phosphate + S2 (60 kg) + PSB + EM solution followed by treatment T10 Rock phosphate + S2 30 kg + PSB + EM solution at 30, 60 and 90 days of incubation (Table 3). The lowest activity of alkaline phosphatase activity was observed in the 90 days of

incubation in all the treatments over the 60 and 30 days of incubation. With increase in the incubation period from 30 to 90 days of incubation a significant decrease in available phosphorus was also observed due to precipitation reaction. The decrease in the alkaline phosphatase activity at 90 days incubation may be associated with a decrease in microbial population at 90 days of incubation over the 30 and 60 days of incubation.

Olander and Vitousek (2000) [6] observed that phosphorus addition suppressed phosphatase activity. The decrease in the phosphatase activity in the sole treatment of rock phosphate may be due to the above reason. Gyaneshwar *et al.* (1982) [5] reported that the growth of bacteria was inhibited due to P limitation through rock phosphate. The phosphatase activity was beneficially influenced by NPK elements. Zahir *et al.* also observed that a significant increase in the alkaline phosphatase activity was observed with increase in ineralization of the phosphate compounds. The results of this investigation are in close conformity with their observations. Tabatabai and Bremner (1972) [11] and Cookson (1999) [4] reported that the phosphatases plays an important role in transforming organic phosphorus in to inorganic forms.

Parthasarthi and Ranganathan (2000) [8] reported that the increased activity of the enzyme alkaline phosphatase may be ascribed to the active microbial population and optimal moisture conditions. These observations are in agreement with the observations in this study. Sarapatka and Krskova (1997) [10] observed that, the increase in the soil phosphatase enzymes play a major role in ineralization of organic phosphorus substrates. This may be one of the probable reasons for increase in the phosphate content in the 30 and 60 days of incubation.

Table 3: Effect of treatments on available sulphur, available phosphorus and total phosphorus of soil during incubation

S. No.	Treatments	Available phosphorus (kg ha-1)			Total phosphorus (mg kg-1)			P nitrophenol (mg $ml^{-1}hr^{-1}$)		
		30 DAS	60 DAS	30 DAS	60 DAS	90 DAS	90 DAS	60 DAS	90 DAS	90 DAS
T_1	Absolute control	9.40	10.45	10.40	162.0	159.0	164.0	7.80	7.10	6.60
T_2	GRD (50:75:00)	18.56	18.90	17.20	324.0	340.2	344.3	8.10	7.40	6.70
T_3	Rock Phosphate + S_0	13.18	14.70	13.40	237.0	264.6	267.0	7.40	7.80	6.30
T_4	R. P. + S_0 + PSB	13.49	15.10	13.10	242.0	271.8	274.2	8.70	8.10	7.90
T_5	R. P. + S_0 + EM Culture	13.45	15.02	14.80	242.0	270.3	268.0	8.64	8.20	7.95
T_6	R. P. + S_0 + PSB + EM Culture	13.85	15.30	14.00	249.0	275.4	279.0	9.95	9.29	8.70
T_7	R. P. + S_1	13.95	17.78	15.70	254.0	320.04	327.04	8.00	7.80	7.40
T_8	R. P. + S_1 + PSB	14.01	15.52	14.90	252.1	333.36	339.3	9.64	9.20	8.85
T_9	R. P. + S_1 + EM Culture	13.80	18.61	15.70	253.4	334.9	342.1	9.45	9.20	8.30
T_{10}	R. P. + S_1 + PSB + EM Culture	14.10	18.90	16.20	254.3	340.2	347.2	10.20	10.20	9.70
T_{11}	R. P. + S_2	14.97	19.20	17.80	269.4	345.6	345.0	8.20	7.80	7.30
T_{12}	R. P. + S_2 + PSB	15.71	21.10	17.00	282.8	379.8	381.6	9.70	9.45	9.39
T_{13}	R. P. + S_2 + EM Culture	15.65	21.01	19.20	281.7	378.2	384.4	9.54	9.20	8.95
T_{14}	R. P. + S_2 + PSB + EM Culture	15.99	22.57	19.70	287.8	400.2	390.0	11.50	11.60	11.00
	S.E. +	0.887	0.949	0.891	1.290	1.785	1.436	0.29	0.17	0.34
	C.D. at 5%	2.685	2.871	2.697	3.905	5.403	4.346	0.88	0.52	1.03

Summary and Conclusions

The available and total phosphorus content of soil was increased with increase in the incubation period stage up to 90 days. The alkaline phosphatase activity was highest at the 30 day incubation stage. The phosphatase activity was decreased slightly at the 60 days stage and was observed to be lowest at the 90 days incubation stage. The higher phosphatase activity at 30 day and 60 day stage indicated higher microbial population at the initial stages of incubation of the microbial treatments.

Incubation study

The available and total P content increased in all the treatments with microbial incubation and elemental sulphur application. It can therefore be concluded that the release of phosphorus from rock phosphate can successfully be done by application elemental sulphur @ 60 kg ha-1 along with incubation of PSB and EM solution.

References

1. Ali Masood. Consolidated report on Kharif crops. DPR, Kanpur, 1991.
2. Anonymous. Agril. Statistics at a glance 2009. Directorate of Economics and Statistics, Department of Agril. And Co-operation Ministry of Agril. Government of India. 2009, 122.
3. Ashby DL, Fenster WE, Attoe OJ. Effect of partial acidulation of elemental sulphur on availability of phosphorus in rock phosphate. Agron J. 1966; 58:621-625.
4. Cookson P. Special Variation in soil urease activity around irrigated date palms, Arid Soil Res. Rehabil. 1999, 155-169.
5. Gyaneshwar P, Naresh Kumar G, Parekh LJ. Effect of buffering on the phosphate solubilizing ability of micro-organisms. World J. Microbio. Biotechnol. 1982; 14:669-673.
6. Olander LP, Vitousek PK. Regulation of soil phosphatase and chitinase activity by N and availability. Biogeochemistry. 2000; 49:175-190.
7. Panse VG, Sukhatme PV. Statistical method for Agricultural workers. Publ. ICAR, New Delhi. 1978, 115.
8. Partha Sarathi K, Ranganathan LS. Aging effect on enzyme activities in Pressmud vermicasts of *Lampito mauritii* (Kinberg) and *Eudrilus eugeniae* (Kinberg) Bio. Fert. Soils. 2000; 30:347-350.
9. Roy P, Tarafdar JC, Singh AP. Enhancing phosphorus release from mussoorie rock phosphate by blending with organic materials and phosphate solubilizers. J Indian Soc. Soil Sci. 1999; 47(2):372-375.
10. Saraptka B, Krskova M. Interactions between phosphatase activity and soil characteristics from some locations in the czech republic. Rostlinna Vyroba. 1997; 43:415-419.
11. Tabatabai MA, Bremner MM, Assay of urease activity in soils. Soil Biology Biochem. 1972; 4:479-487.

12. Zahir Ahmad Zahir, Ateeq Muhammad ur, Malik Rehman, and Arshad Muhammad. Soil enzymes research: A Review on line. J Biol. Sci. 2001; 1(1):299-307.